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RECORD AND DISCLOSURE OF INVENTION

FOR USE BY NAVY
INTELLECTUAL PROPERTY OFFICE

DATE DISCLOSURE RECEIVED	NAVY CASE NO.
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INSTRUCTIONS: A Navy employee should use this form when submitting an invention disclosure to the Department of the Navy. Fill each blank with the requested information or enter "NONE" as appropriate. Original and two copies should be printed or typed and forwarded to the intellectual property office responsible for providing services to your activity. Where space on the form is inadequate, enter "see attached page," use plain pages as needed, and identify item by number. When completely executed, this form becomes an important legal document useful in proving priority of invention. This form may also be used by a contractor or grantee for disclosing an invention to the Navy.

PART 1. RECORD OF INVENTION

1. INVENTOR(S)	ADDRESS	POSITION TITLE	EMPLOYER (Activity & Code No., or Company & address)
Philip Sherwood Davis	2114 Pebble Beach Place Panama City Beach, FL 32408	Research Scientist	Naval Surface Warfare Center- Dahlgren Division- Coastal Systems Station 6703 W. Highway 98 Panama City, FL 32407

2. DESCRIPTIVE TITLE OF INVENTION

Underwater Power Generator

3. CONCEPTION, INITIAL RECORDS AND RESULTS OF FIRST MODEL

a. EARLIEST DATE AND PLACE INVENTION WAS CONCEIVED (*Identify persons and records to support date and place*)

Philip Sherwood Davis

January 23, 2003

Building 404

Naval Surface Warfare Center- Dahlgren Division- Coastal Systems Station

6703 W. Highway 98

Panama City, FL 32407

b. DATE AND PRESENT LOCATION OF FIRST SKETCH, DRAWING OR PHOTO AND FIRST WRITTEN DESCRIPTION (*Such as notebook entries, etc.*)

January 23, 2003

Building 404

Naval Surface Warfare Center- Dahlgren Division- Coastal Systems Station

6703 W. Highway 98

Panama City, FL 32407

c. DATE AND PLACE OF COMPLETION OF FIRST MODEL, PROTOTYPE, PRELIMINARY SYNTHESIS, FORMULATION, ETC., AND ITS PRESENT LOCATION

None

d. DATE AND PLACE OF FIRST TEST OR OPERATION AND THE RESULTS (*Give name and address of witnesses, and present location of records*)

None

4. OTHER RECORDS (*Notebook entries, descriptions, reports, drawings, etc.*)

IDENTIFICATION	DATE OF DOCUMENT	PRESENT LOCATION
None	None	None

5. OTHER INDIVIDUALS TO WHOM INVENTION WAS DISCLOSED

NAME	ACTIVITY OR COMPANY INDIVIDUAL REPRESENTS	DATE DISCLOSED	TYPE (oral or written disclosures)
Dr. Ted Clem	Naval Surface Warfare Center- Dahlgren Division- Coastal Systems Station 6703 W. Highway 98 Panama City, FL 32407	January 27, 2003	Oral
Rudy Arrietta	Naval Surface Warfare Center- Dahlgren Division- Coastal Systems Station 6703 W. Highway 98 Panama City, FL 32407	January 28, 2003	Oral
Jody Wood-Putnam	Naval Surface Warfare Center- Dahlgren Division- Coastal Systems Station	January 28, 2003	Oral

Filename: "invndisc1form"

	6703 W. Highway 98 Panama City, FL 32407		

NAVONR 5870/35 (6-96)

Formerly NAVOCNR 5870/35 (11-89)

6. DATE AND PLACE OF OTHER TESTS OR OPERATIONS, AND THE RESULTS (List name and address of witnesses and identify present location of records)

None

7. IDENTIFY ANY PAST, PRESENT OR CONTEMPLATED USE, SALE, OR PUBLICATION OF THE INVENTION

Possible sale to underwater glider manufacturers.

These manufacturers would resell the glider to military and commercial firms.

Possible commercial uses include underwater hydrocarbon and mineral exploration using this device as a power source for the sensor platform.

Nonmilitary government uses include long term oceanographic studies.

8. LIST ANY CLOSELY RELATED PATENTS, PATENT APPLICATIONS AND PUBLICATIONS OF YOURS OR OTHER PERSONS

None

PART II. DISCLOSURE OF INVENTION

Attach on separate sheets of paper a full and complete description of the invention, using the outline given below.

a. PURPOSE. State the purpose of the invention.

b. BACKGROUND. Describe the old methods, materials or apparatus used to perform the purpose of the invention and give their limitations and disadvantages.

c. DESCRIPTION AND OPERATION. Describe clearly and completely the best mode of the invention and give a detailed description of its operation and use. Sketches, prints, photos, or other illustrations should be attached. In the description, use reference characters to refer to components in attached illustrations.

d. ADVANTAGES AND NEW FEATURES. State the advantages of the invention over the old methods, materials or apparatus described in paragraph b. above, and the features believed to be new.

e. ALTERNATIVES. Indicate any alternative methods, materials, or apparatus of the invention.

f. CONTRIBUTIONS BY INVENTORS. If this is a joint invention, indicate what contribution was made by each inventor.

PART III. CERTIFICATION OF INVENTORS

I certify that the invention disclosed herein and in the attached documents is the sole joint invention of the undersigned and that the statements and answers are true to my best knowledge and belief.

Date	Signature

PART IV. CERTIFICATION OF WITNESSES

I certify that the invention described herein and in the attached documents has been disclosed to and understood by me.

Date	Signature	Business Address
Date	Signature	Business Address

NAVONR 5870/35 (6-96) (Reverse)

**DEPARTMENT OF THE NAVY
OFFICE OF NAVAL RESEARCH
ARLINGTON VA 22217**

DIRECTIVE: ONR 5870.1
NAVY CASE NO.

PATENT RIGHTS QUESTIONNAIRE

PRIVACY ACT STATEMENT - Under the authority of Executive order 10096, information regarding the making of your invention is requested in order to make a patent rights determination. The information provided by you will become a permanent part of the Navy patent case file on your invention. The information provided will not be divulged without your written authorization to anyone other than agencies of the U.S. Government with a proper interest in Government rights in inventions. You are required to provide this information and failure to do so could conceivably result in adverse performance evaluation or disciplinary action.

INVENTOR (<i>Last name, first, middle</i>) Davis, Philip, Sherwood	COGNIZANT PATENT COUNSEL
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DESCRIPTIVE TITLE OF INVENTION Underwater Power Generator
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CONCISE DESCRIPTION OF INVENTION

The invention pertains to the underwater generation of electric power. This device will generate power from the difference in external water temperature and the internal temperature of the vessel on which it is contained. Therefore, the vessel will have to maintain a difference in the external water temperature and the internal section of the vessel to generate power. The device will consist of two main parts; thermoelectric elements and a phase change material. The design of this device is as follows. The thermoelectric elements are placed between the surrounding water and the phase change material. In general, one side of the thermoelectric element will be in thermal contact with the surrounding seawater and the other side of the thermoelectric element will be in thermal contact with the phase change material inside.

INSTRUCTIONS

Under Executive order 10096 of 23 January 1950, as amended, and SECNAV Instruction 5870.3, it is necessary to determine the relative rights of the inventor and the Government to the invention described above. This determination depends on the circumstances under which the invention was made. The making of an invention generally requires its conception or discovery and also work on it in the form of writings, sketches or drawings or a model of full size device (or a combination of these) from which it can be established that the invention is considered "made" depends upon the circumstances surrounding each invention. For the purpose of this questionnaire, this date may be considered the earliest or first time the essential elements of the invention were fully and clearly disclosed in writings,

sketches or drawings, or in a model or full size device in such a manner that it was clear the invention was sound in principle and could be reduced to practice therefrom by one skilled in the field of the invention.

The inventor should CAREFULLY READ THE ENTIRE QUESTIONNAIRE. He should then answer the questions as completely as possible, using the above definition of the date invention was "made" and the above description as the definition of the invention. Completion of questionnaire includes signatures at the end of the form by inventor and his supervisor. Original and one completed copies are to be returned to the cognizant Patent representative.

I. INVENTOR'S EMPLOYMENT AT THE TIME INVENTION WAS MADE

1. JOB TITLE Research Scientist	2. GRADE ND-III	3. ACTIVITY (<i>Name and Location</i>) Naval Surface Warfare Center- Dahlgren Division- Coastal Systems Station			
4. LABORATORY OR DEPARTMENT Littoral Warfare Technology and Systems	5. DIVISION OR BRANCH Littoral Warfare Sensing Technology	6. SECTION OR UNIT Code R23- Magnetics and Unconventional Sensors			
7. OFFICIAL WORK ASSIGNMENT	YES NO	OFFICIAL WORK ASSIGNMENT	YES	NO	
a. TO INVENT OR IMPROVE OR PERFECT ANY PROCESS, MACHINE, MANUFACTURE, OR COMPOSITION OF MATTER	<input type="checkbox"/>	<input checked="" type="checkbox"/>	b. TO CONDUCT OR PERFORM RESEARCH OR DEVELOPMENT WORK	<input checked="" type="checkbox"/>	<input type="checkbox"/>
c. TO SUPERVISE, DIRECT, COORDINATE OR REVIEW GOVERNMENT FINANCED OR CONDUCTED RESEARCH OR DEVELOPMENT WORK.	<input type="checkbox"/>	<input checked="" type="checkbox"/>	d. TO ACT IN LIAISON CAPACITY AMONG GOVERNMENTAL OR NON-GOVERNMENTAL AGENCIES OR PERSONS DOING SUCH RESEARCH OR DEVELOPMENT WORK	<input type="checkbox"/>	<input checked="" type="checkbox"/>

II. ASSIGNMENT OF INVENTION

Executive Order 10096 provides that Government employees who are employed or assigned to perform any of the duties listed in Section I, items 7a through 7d above, and who make inventions as a direct result of, or make inventions having a direct relation to their assigned duties, may be required to assign the entire right, title and interest in the invention to the Government. Therefore, if any of the question 7a through 7d above were answered in the affirmative, and the inventor believes that the invention was made as a direct result of, or related directly to his assigned duties, and in the inventor may sign the statement below and omit Sections III and IV of this questionnaire. In case of doubt, assistance should be requested from a Navy Patent representative.

AS THE INVENTION DESCRIBED HEREIN WAS MADE AS A DIRECT RESULT OF THE PERFORMANCE OF MY ASSIGNED DUTIES, I HEREBY AGREE TO ASSIGN THE ENTIRE RIGHT, TITLE AND INTEREST IN THE INVENTION TO THE GOVERNMENT AND I UNDERSTAND THAT I WILL RETAIN NO RIGHTS IN THE INVENTION.

INVENTOR'S SIGNATURE

DATE

III. RELATIONSHIP BETWEEN INVENTION AND INVENTOR'S ASSIGNED DUTIES

ITEM	YES	NO	ITEM	YES	NO
1. DID INVENTOR HAVE THE IDEA FOR THE INVENTION BEFORE WORK WAS DONE ON IT BY ANYONE ON GOVERNMENT TIME?		X	3. WAS THIS TASK ASSIGNED TO INVENTOR BEFORE HE "MADE" THE INVENTION?		X
2. WAS THE INVENTION A SET GOAL OF A SPECIFIC OR DETAILED TASK ASSIGNED TO THE INVENTOR?		X	4. COULD THIS TASK HAVE BEEN SUCCESSFULLY COMPLETED WITHOUT "MAKING" AN INVENTION?	X	

5. INVENTOR'S OFFICIAL DUTIES AT THE TIME THE INVENTION WAS "MADE" (specify in detail those duties or assigned tasks or projects which were related or closely connected to the invention. If in doubt, attach a copy of applicable position description or as much of it as sets forth pertinent duties. If no related duties, tasks or projects were assigned to the inventor, state any related or closely connected tasks or projects assigned to the inventor's Branch or Section, if known. If the invention did not closely relate to either the inventor's duties or those of his Branch or Section, give a general statement of duties assigned).

Inventor was tasked to tabulate possible sensor packages for underwater gliders.

6. DESCRIBE THE RELATIONSHIP BETWEEN THE INVENTOR AND THE INVENTOR'S OFFICIAL DUTIES, ASSIGNED TASKS OR PROJECTS AS STATED IN ITEM #5 ABOVE.

Inventor was tasked by Dr. Ted Clem to perform the duties stated in #5.

IV. MAKING OF THE INVENTION

1. CIRCUMSTANCES SURROUNDING THE "MAKING" OF THE INVENTION (State when, where and how)

The invention was developed in mid January 2003.

The invention was developed at the inventor's desk in building 404.

The inventor realized that the usefulness of the underwater glider would be greatly enhanced, if it contained a power generation device.

2a. WAS THE INVENTION DESCRIBED IN DRAWINGS, SKETCHES AND WRITINGS FROM WHICH INVENTION COULD BE CONSIDERED "MADE"; IF "NO" OMIT 2b.	YES <input checked="" type="checkbox"/>	NO _____	3a. WAS A MODEL OR FULL SIZE DEVICE MADE OF THE INVENTION OR ITS PROCESS TRIED OUT? IF "NO", OMIT 3a AND 3c. b. WAS THE MODEL OR DEVICE MADE AND TESTED OR THE PROCESS TRIED OUT BECAUSE IT WAS (1) DOUBTFUL WHETHER IT WOULD WORK AT ALL (2) DESIRED TO DETERMINE ITS USEFULNESS TO NAVY c. HOURS SPENT BY INVENTOR IN MAKING THE MODEL OR DEVICE OR TRYING OUT THE PROCESS OWN TIME _____ GOVT TIME _____	YES _____	NO <input checked="" type="checkbox"/>
	XXX	XXX		XXX	XXX
2b. HOURS SPENT BY INVENTOR IN MAKING THESE DRAWINGS, SKETCHES AND WRITINGS OWN TIME 4 hrs GOVT TIME 4 hrs					
4. WAS THE INVENTION DEVELOPED FROM A CRUDE FORM TO A PRACTICAL FORM USING GOVERNMENT TIME, FACILITIES, EQUIPMENT, MATERIALS, FUNDS, SPECIAL INFORMATION OR TIME OR SERVICES OF OTHER GOVERNMENT EMPLOYEES?		X			
5. IN THE MAKING OF THE DRAWINGS, SKETCHES AND WRITINGS AND ANY MODEL OR FULL SIZE DEVICE OF THE INVENTION AND IN THE OPERATING, TESTING, TRYING OUT AND DEVELOPMENT OF THE INVENTION, WHAT WERE THE CONTRIBUTIONS OF THE GOVERNMENT AND THE INVENTOR OF FACILITIES, EQUIPMENT, MATERIALS, FUNDS SPECIAL INFORMATION OR TIME OR SERVICES OF OTHER GOVERNMENT EMPLOYEES?					

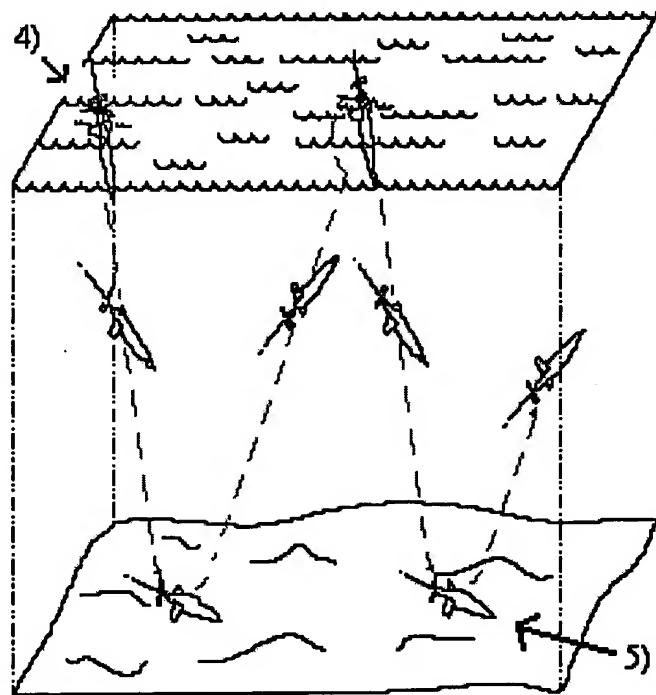
a. GOVERNMENT CONTRIBUTION

The government provided the use of a computer and writing materials.

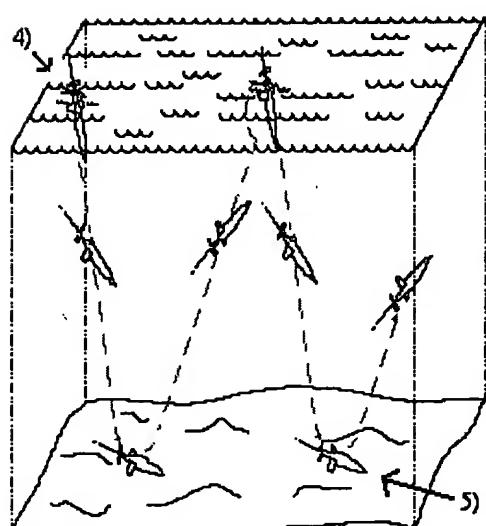
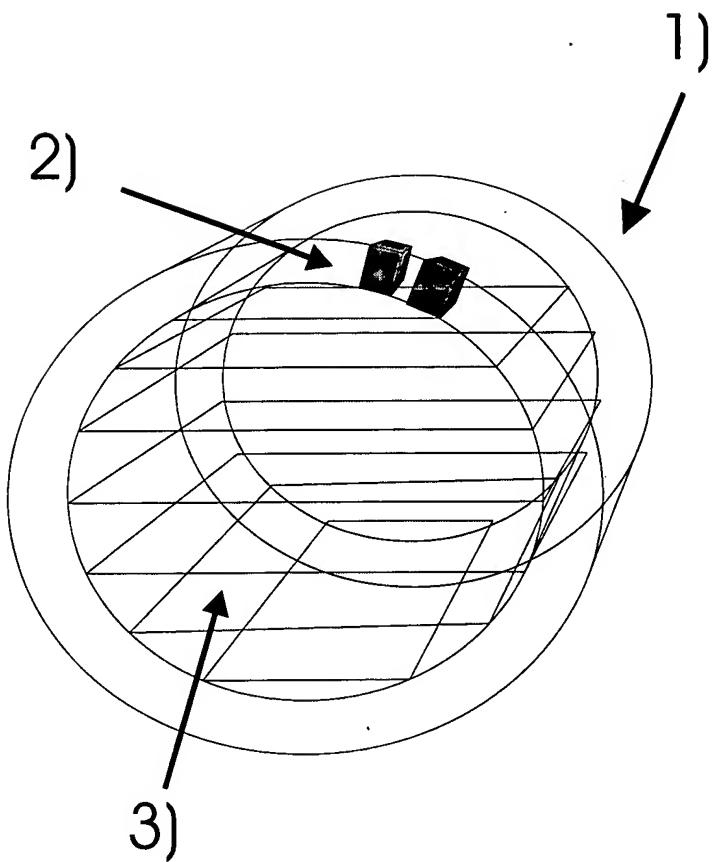
b. INVENTOR'S CONTRIBUTION

The inventor developed the idea.

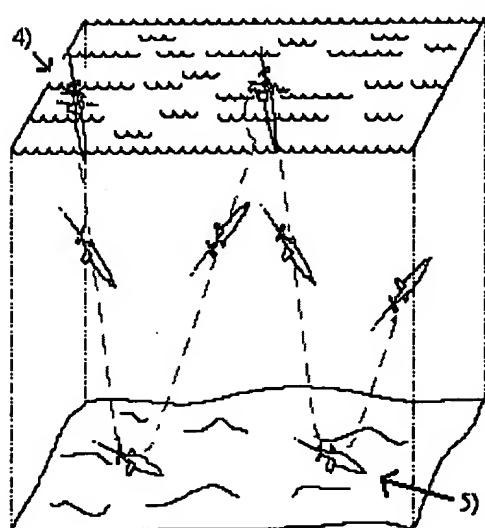
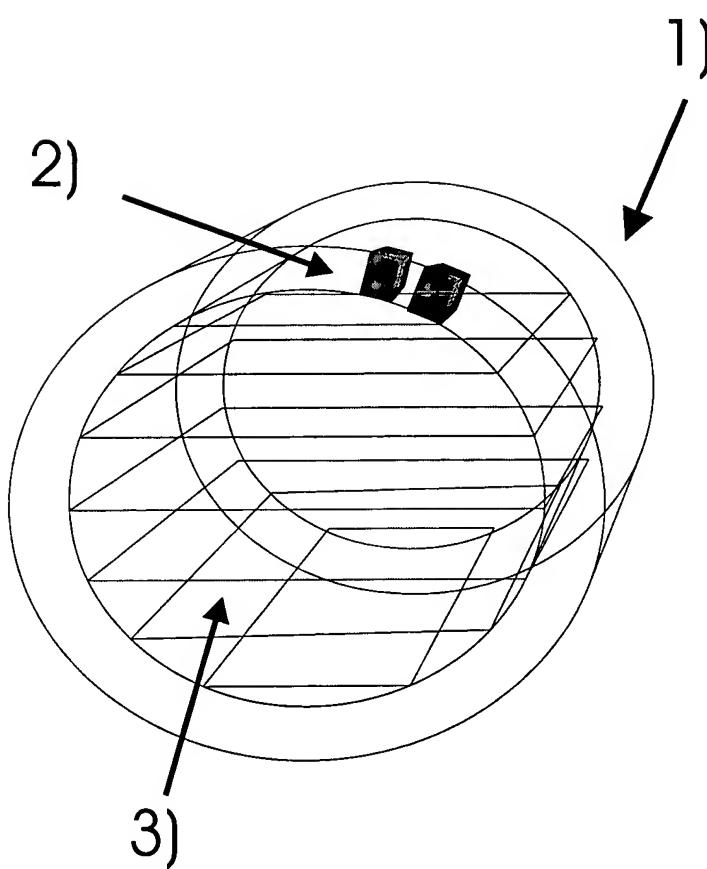
INVENTOR (Signature)	CONCURRENCE
	SIGNATURE OF INVENTOR OR SUPERVISOR
NAVONR 5870/3 (REV 5-83)	DATE



Filename: "concept of operation"



Filename: "Figures"



Filename: "Figures1"

A)

The purpose of the invention is to generate electric power underwater; specifically from the naturally occurring ocean thermocline.

B)

Previously, energy was brought with the vehicle in the form of batteries. There is one main disadvantage of this system. That is, the system has only a fixed amount of energy. Therefore, mission duration with this type of power system is limited by the amount of energy contained in the batteries and the rate of power consumption during the mission.

C)

The best mode of operation for this device is for it to be contained on an underwater vehicle, which transits the ocean's thermocline at regular intervals.

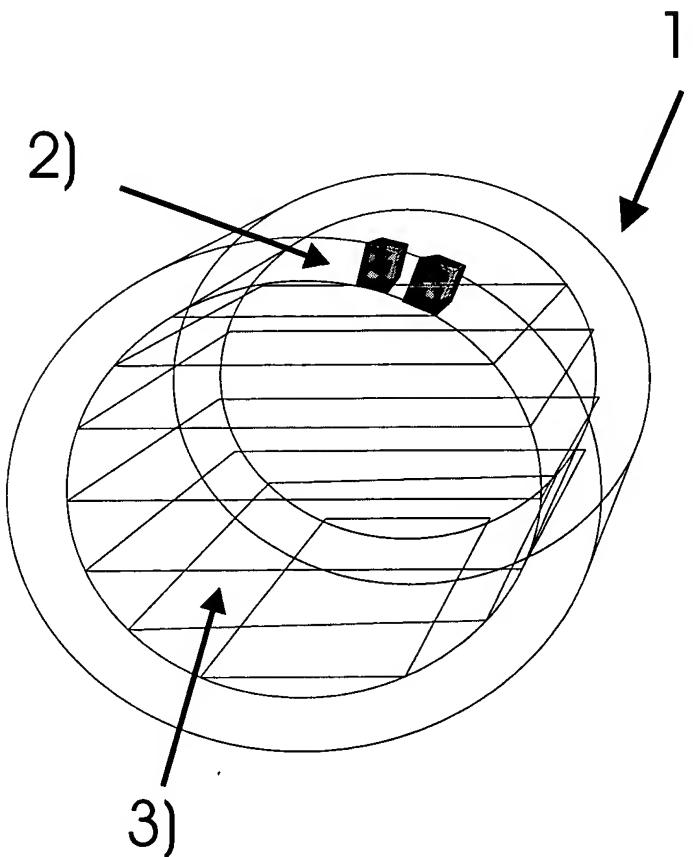


Figure 1 Thermoelectric generator device.

As can be seen in Figure 1 the design of this device is simple. The outside of the vessel at point 1) is in thermal contact with the surrounding water. As the vessel transits the ocean's thermocline, the phase change material at point 3) remains at a constant temperature, which is an average of the extreme temperatures encountered. This action produces a temperature gradient across the thermoelements at point 2). The ensuing heat transfer, either into or out of the vessel is then converted directly into electrical energy. Although this device will work with an almost infinite number of materials, it is proposed, that the thermoelements at point 2) be made of either bulk Bi_2Te_3 or thin film quantum lattice $\text{Bi}_2\text{Te}_3 - \text{Sb}_2\text{Te}_3$. These materials are proposed, because they are the most efficient at the expected operational temperatures. Furthermore, paraffin wax is proposed as the phase change material at point 3). This material possesses several properties, which make it a good candidate for this application. First, it has a large heat of fusion. This allows the material to maintain a constant temperature, even after absorbing a relatively large amount of heat. Second, it can be contained in the capillaries of other materials. This property allows the overall thermal mass to maintain a constant density, which is important to underwater glider operation. Finally, the phase change temperature of

paraffin wax can be altered to allow for the maximum power production. This will depend on the average operating temperature of the vessel.

For completeness a discussion of the operation of an underwater glider will now be given. Although, the underwater power generator may be used on other vessels and devices, the underwater glider is considered the most likely.

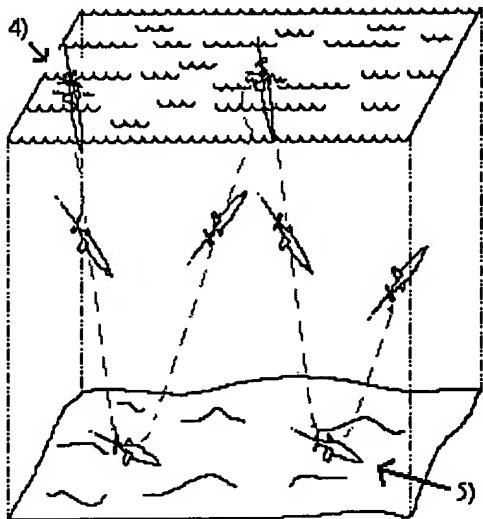


Figure 2 Normal underwater glider mode of operation.

Figure 2 illustrates the normal motion of operation for an underwater glider. The glider begins its motion at point 4) on the surface of the water column. At this time, the glider begins to change its buoyancy and starts to sink. Adjusting the attack angle of its wings provides forward thrust to the vehicle. At point 5), where the depth can be on the order of 1000 meters and after passing through the thermocline, the glider begins to change its buoyancy again to rise to the surface to repeat the cycle again.

D)

Thermoelectric elements have been used to generate power from thermal gradients for years. This device operates on this same principle. However, no one has applied thermoelectric materials to power generation using the ocean's thermocline. Furthermore, the use of the phase change material as a thermal buffer in energy conversion devices, such as solar cells, has been done. However, the use of a phase change material in conjunction with thermoelectric elements to produce power from the ocean's thermocline is new. In conclusion, this device will enable these underwater vessels to do more tasks for longer periods of time, since the vessel will be generating power while it is at sea.

E)

Other thermoelectric materials, which are currently known and possibly useful for this device, are thin film $\text{Bi}_2\text{Te}_3 - \text{Sb}_2\text{Te}_3$ superlattice structures. Alternative methods and apparatus are not currently known.